On the Origin and Formation of Roots. In a Letter from Thomas Andrew Knight, *Esq. F.R.S. to the Right Hon. Sir* Joseph Banks, *K.B. P.R.S.* Read February 23, 1809. [*Phil. Trans.* 1809, *p.* 169.]

The object of this paper is to show, that the roots of trees are always generated by the vessels which pass from the cotyledons of the seeds, or from the leaves through the leaf-stalks and bark, and that they never spring immediately from the alburnum.

The radicle, which proceeds from the seed, appears to the author to differ from other roots in its mode of growth, since it elongates, by interstitial increase, like the intervals between the buds in the succulent annual shoot; but roots, on the contrary, elongate only by new parts added to their extremity, and never by the extension of parts previously formed.

The proper roots, which come first into existence, spring from the point of the radicle; and since there is at that time no alburnum, it is evident they must arise from some other source.

At first they consist solely of cellular substance, within which cortical vessels are next generated; by these the alburnum is subsequently deposited, in the form of wedges, meeting in the centre.

If a portion of bark be removed from a vine, in a circle, round the stem, and any wet substance be applied to it, roots are soon emitted from the upper edge of the decorticated space; and when the alburnum dies so as to obstruct the progress of sap through it, buds are usually protruded from the lower edge, but never from the upper; the roots deriving their matter from the fluid that descends through the cortical vessels, and buds from the ascending sap.

In some varieties of the apple-tree, Mr. Knight observes, there are many rough excrescences on the trunks and branches, which, under different circumstances, form either buds or roots, and these varieties are accordingly very easily propagated by cuttings. When such excrescences had begun to form upon some trees of two years old, mould was applied to some of them in the spring, and roots were found to form early in the summer. But when mould was applied to other trees of the same age and variety, from which the top had been cut at a short distance above the excrescence, no roots were emitted for want of descending sap, but buds were formed instead.

The author observes, that both alburnum and bark contain true sap; but whether that which descends to form roots differs essentially from that which ascends to form buds, he thinks it nearly impossible to decide: he is, however, much more disposed to attribute the formation of different organs to the different action of the vessels, than to any difference of the fluids from which they are formed.

After alburnum has been formed in the roots, it then has the power of producing buds from its upper extremity, as well as fibrous roots from its lower extremity. The continuance of the entire root in the state of alburnum, appears owing to moisture; for if the mould be taken away so as to expose part of a root to the air, that part is subsequently found to contain heart wood.

The formation of buds from the potatoe, beneath the soil, may ap-

pear an exception to the general rule respecting buds and roots; but the author observes, that the tuber differs but little from a branch which has dilated instead of extending itself. The runners, which give existence to the tubers beneath the soil, are very similar in organization to the stem of the plant; and if exposed, readily emit leaves, and perform all the functions of the stem; and, on the other hand, Mr. Knight has shown, in a former memoir, that the buds on any part of the stem may be made to produce tubers similar to those formed beneath the soil; but he has never, under any circumstances, been able to obtain tubers from the fibrous roots of the plant.

Many naturalists have imagined the fibrous roots of all plants to be of annual duration only, because those of bulbous and tuberous plants certainly are so; but Mr. Knight observes, that the organization of trees is extremely different; and he has not found any portion of their roots to be deciduous.

On the Nature of the intervertebral Substance in Fish and Quadrupeds. *By* Everard Home, *Esq. F.R.S.* Read February 23, 1809. [*Phil. Trans.* 1809, *p.* 177.]

The author, having observed a new species of joint in the *Squalus maximus* of Linnæus, takes occasion to trace the successive gradations of a similar structure, through various kinds of fish, to the more remote resemblance to be found in quadrupeds and in men.

In the Squalus each joint of the spine approaches, in some measure, to that which is termed the ball and socket joint, as a concave surface of each vertebra is applied to a ball; but the ball, in this instance, is not, as in other cases, a smooth surface covering a solid bone, but a collection of fluid contained in a bag that is nearly spherical, round which the concave surfaces of the vertebræ are moved.

In a fish of thirty feet in length, the diameter of the body of one of the largest vertebræ measured seven inches; the quantity of fluid in one of the cavities amounted to three pints; the ligamentous substance, which unites the vertebræ, being nearly one inch in thickness, externally very compact and elastic, but internally possessed of but little elasticity.

The elasticity of these ligaments preserves the straitness of the spine when it is not acted upon by the muscles, or by other external force; and though the extent of motion, in any one joint, must be small, their number affords considerable latitude of motion.

Since the vertebræ, in other fish, are found with concavities in each surface, it was natural to expect a corresponding resemblance in the intervertebral structure; and in the skate this was found to be the case, and the cavity nearly spherical, as in the Squalus. In the common eel it is more oblong, the longitudinal diameter exceeding the transverse one by about one third.

In the sturgeon the structure varies considerably, as the cavities communicate with each other by apertures through the bodies of the vertebræ, which in this fish are cartilaginous rings, connected toge-